Name ____

DNA Structure Simulation

In most living organisms, the carrier of the genetic information is deoxyribonucleic acid (DNA). The intricate structure of the DNA molecule carries the genetic code for inherited characteristics from one generation to the next.

The DNA molecule consists of thousands to millions of nucleotides bonded together in an interconnected chain. Nucleotides have 3 components:

- A sugar molecule
- A phosphate group
- And a nitrogenous base

In DNA, the sugar is a five-carbon molecule called deoxyribose. The deoxyribose sugars are linked together by phosphate groups at the number three and number five carbons of the sugars. The number three carbon end, or three-prime (3') position, of one sugar is bonded by the phosphate group to the number five carbon, or 5' position, of another sugar. This process is repeated to form very long polynucleotide chains.

The DNA molecule has as its structural backbone two antiparallel sugar-phosphate chains. The two single strands of DNA are interconnected via hydrogen bonds between nitrogenous bases. Of the four nitrogenous bases, adenine (A) and guanine (G) are classified as purines and cytosine (C) and thymine (T) as pyrimidines. Because of their molecular structure, the nitrogenous bases bond very specifically:

- Adenine bonds only with thymine
- Cytosine bonds only with guanine

It is this strict base pairing between strands that dictates the spiraling DNA structure known as the double helix.

Assembly

Use the key in the table below to assist you in building a DNA molecule.

Kit Component	***Part of DNA molecule***	***Quantity Needed***
White beads	Deoxyribose sugar	30
Red beads	Phosphate group	30
Orange beads	Adenine (A)	9
Green beads	Guanine (G)	6
Blue beads	Cytosine (C)	6
Yellow beads	Thymine (T)	9
Clear connectors	Hydrogen bonds	15

To create your 30 nucleotides:

1. Attach a phosphate group (red bead) to the 5' position of the deoxyribose sugar (white bead)
2. Now attach any one of the four nitrogenous bases
   (adenine-orange, guanine-green, cytosine-blue, thymine-yellow)
   to the 1' position of the same sugar.
3. Separate the 30 nucleotides you created into 4 groups according to their nitrogenous bases (orange, green, blue, yellow)

Now you are going to construct a single-stranded polynucleotide chain using 15 of the nucleotides you just created. To construct the first strand of your DNA molecule, follow the directions below:

4. Attach the phosphate group (red bead) of one nucleotide to the 3' peg of the sugar (white bead) of another nucleotide.
   - Use 5 nucleotides with adenine, 3 with guanine, 3 with cytosine, and 4 with thymine
   - For this model, you may attach the nucleotides in any order of color

To form the typical double-stranded DNA molecule, a *complementary*, *antiparallel*strand of DNA nucleotides must now be constructed to bond with the initial strand. Link the remaining 15 nucleotides together by following the directions below:

5. The 3' pegs of the new strand should be aligned in the opposite direction of the initial strand
6. The nucleotides should be lined up so that cytosine on the initial strand pairs with guanine on the new strand and vice versa
7. Thymines on the initial strand should be matched to new adenine nucleotides and vice versa
8. Connect the nitrogenous bases on each strand to each other using hydrogen bonds (clear connectors)
    - Again, be sure A pairs with T and C pairs with G
9. Grasp the completed DNA molecule by the base pair at each end of the double strands
10. Gently twist the molecule into the form of a spiraling rope ladder
    - Be careful not to separate the hydrogen bonds between base pairs

Finally, compare the DNA molecule you constructed to that created by another group to answer the following questions.

1. What similarities do you notice about both groups' DNA molecules?

2. What differences do you notice about both groups' DNA molecules?

3. What do you notice about the 5' and 3' ends of each strand of DNA?

4. Compare the **number** of adenines to the number of EACH of the other nitrogenous bases. What do you notice?

5. Compare the **number** of guanines to the number of EACH of the other nitrogenous bases. What do you notice?